

Power Tools – Saws, Torches, Fans

Introduction

Rescue Companies carry a wide variety of cutting tools designed for many different operations. Personnel assigned to a rescue squad or extrication truck may be required to perform tasks ranging from cutting ventilation holes in a roof to removing doors from a car to cutting a hole in a concrete floor. Hydraulic and pneumatic cutting tools are discussed in other modules. This module will focus on saws and torches that are commonly found of rescue squads and extrication trucks.

Saws

Portable saws are an excellent resource on both the fire ground and rescue scene. Rescue squads and extrication trucks carry both gasoline-powered saws and electric/battery-powered saws.

Electric-Powered Saws

Circular Saws

Circular saws are often associated with construction and carpentry work - not rescue. However, they are a necessity on technical rescue incidents such as structural collapse or trench rescue.

Circular saws can be both electric and battery powered. Electric saws require a 120V power supply and typically operate at 15 amps. Therefore, a sufficient power source must be available to use these saws (smaller 1000W portable generators will not work). For remote operations, cordless saws offer a good alternative. These saws use rechargeable batteries. Manufacturers are constantly improving their battery technology. Currently, lithium-ion batteries used for cordless circular saws range from 18V up to 36V.



The standard blade size for electric circular saws is 7¹/₄". Larger saws with 10¹/₄" blades also exist and are used for cutting 4x4 lumber. Cordless saw blades use smaller 6¹/₂" blades.

Reciprocating Saws



Reciprocating saws are used for demolition work and in situations where the precision of a circular saw are not needed. Unlike circular saws that use the rotary motion, reciprocating saws use a “push and pull” reciprocating motion of the saw blade. Reciprocating saws are often called

“Sawzalls”. Sawzall® is actually the brand name of reciprocating saws manufactured by Milwaukee Electric Tool Corporation.

Like circular saws, reciprocating saws can be electric or cordless. Electric varieties operate on 120V from 10 up to 15 amps. Cordless reciprocating saws use nickel-cadmium (NiCad) or lithium-ion (Li-Ion) batteries similar to those used with cordless circular saws.



Reciprocating saws can be used to cut many different materials. The key to cutting ability and performance is choosing the proper blade. Some saw blades are made specifically for cutting wood or metal. Others blades are general purpose or demolition blades designed to cut wood, metal and plastic. Specialty blades, such as those with tungsten carbide teeth, are also available. Lengths can range from 4” to as long as 12”.



Gasoline-Powered Saws

Gasoline power saws use a small internal combustion engine to provide power. The engines are 2-stroke (or 2-cycle), meaning they only have a compression and combustion stroke. 4-stroke engines, such as those found in most automobiles, have separate intake, compression, combustion and exhaust strokes.

There are both advantages and disadvantages of 2-stroke engines vs 4-stroke engines:

Advantages of 2-Stroke

- Do not have intake/exhaust valves, which simplifies their construction and lowers their weight
- Fire once every revolution, which provides a significant power boost
- Can operate in any orientation
- Good power-to-weight ratio

Disadvantages of 2-Stroke

- Lack a dedicated lubrication system like 4-stroke engines, which means internal components wear faster
- Lack of dedicated lubrication system means that 2-stroke oil must be added to gasoline
- Very inefficient (higher fuel consumption)
- Produce a lot of pollution – both from oil burning with the gasoline and unburnt fuel/air mixtures escaping through the exhaust port



The use of mix-fuel is how many people identify a 2-stroke engine. To create the mixture, 2-stroke oil is added to the gasoline prior to fueling the saw. A 50:1 fuel/oil ratio (2.6 U.S. fluid ounces of oil per 1 gallon of gasoline) is common for many saws. However, it is best to always follow the owner's manual and manufacturer's

recommendations. For instance, Cutters Edge recommends a 100:1 fuel/oil ratio when using their brand of oil, but 50:1 when using other petroleum-based oils.



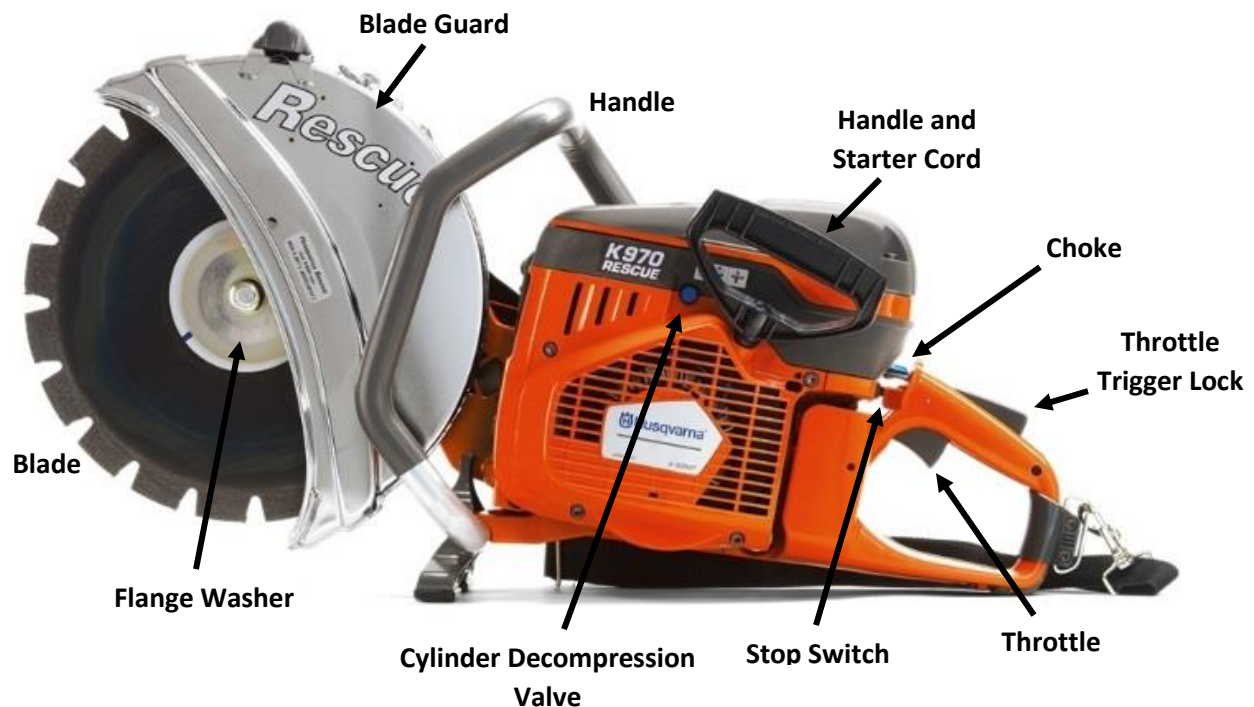
One fairly recent development with 2-stroke engines is the increase in engine problems associated with the use of ethanol in gasoline. Alcohol is said to cause deposits and corrosion and affect the ignition timing of the fuel. The ill effects of E10 gasoline can be combated in a couple different ways: One is to use pre-mixed fuels that do not contain the high levels of alcohol. However, these can be expensive. The other alternative is to use fuel additives such as Marine Sta-Bil or Star-Tron. These stabilizers help prevent the damaging effects of ethanol.



Types of Saws

Rotary Cut-Off Saws

Rotary cut-off saws are larger, more powerful versions of electric-powered circular saws. They are predominantly used for cutting metal, concrete and stone. The [Husqvarna K970](#) and [K760](#) rescue saws are two common types of rotary cut-off saws. (Partner® rotary saws are still carried on some apparatus. In 2006, the Partner® brand became part of Husqvarna.) Some of the parts of the Husqvarna rotary saws are shown below:



Blades

Abrasive Blades

Composite abrasive blades are composed of grit bonded by an organic binding agent. Some of these blades are reinforced with a fabric or fiber base to prevent complete blade failure and breakage during operation should the blade sustain a crack or damage. Abrasive blades are designed for specific applications. Their cutting performance is determined by the type and size of the abrasive material used and the type and hardness of the binding agent. Some examples include:

- Metal
- Concrete/masonry
- Asphalt
- Rail

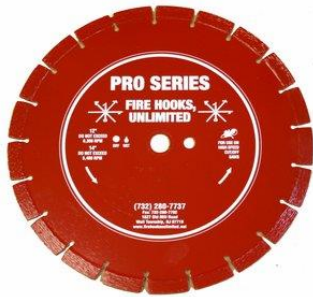


There are many different manufacturers of abrasive blades. It is imperative that the blade and saw manufacturer's recommendations are followed during their use. Some factors to consider include:

- Adhere to minimum and maximum blade diameters
 - Each saw has a maximum allowable blade diameter
 - Abrasive blades are consumed as they are used. Once the blade wears down to the minimum allowable diameter, it should be replaced
- Use the correct type of blade for the material being cut
- Compare the speed rating of the blade to that of the saw. Do not use a blade with a rating lower than that of the saw
- Be cautious with water. While there are some abrasive blades designed to be used with water, there are many that are not.



Diamond Blades



Diamond blades are constructed of a steel wheel with cutting segments containing industrial diamonds. When used properly, they are more durable and will last longer than abrasive blades. Like abrasive blades, diamond blades are designed for specific materials and cutting applications. Some blades are designed only for concrete, masonry and stone. Other diamond blades, specifically those marketed for the fire/rescue service, are designed to cut a wide variety of materials including reinforced concrete, cast iron, rail, steel, brick, rubber, wood, metal, PVC pipe, rebar and plexi-glass.

The blade manufacturer's recommendations must always be followed. When using diamond blades, the operator should also check the following:

- The blade must be mounted to the saw so that it rotates in the proper direction (if applicable)
- The diamond cutting tips can become dull and/or wear when cutting hard surfaces. A sharp blade should always be used.
- Determine if the blade is designed for dry or wet cutting. If it can be used for dry cutting, it may be necessary to regularly pull the blade away from the cutting surface to prevent overheating. If it is designed for wet cutting, water must be used to prevent the blade from overheating.



Toothed Blades

Nearly all manufacturers of gasoline-powered rotary cut-off saws specify that toothed blades should only be used for specialized situations (i.e. rescue work) by trained professionals. Therefore, toothed rotary blades are not common. One manufacturer of a toothed blade specifically designed for the fire service is [Warthog Products, Ltd.](#) They



manufacture the Warthog™ blade that is outfitted on many of the Husqvarna/Partner saws carried on rescue squads and truck companies. The Warthog™ blade is constructed with carbide tips and designed for cutting through floors, walls and roofs. The thick blade design provides strength and durability. However, special mounting procedures exist to ensure that the blade remains properly attached to the saw arbor. The Warthog™ blade, like other specialized tools, can prove beneficial after proper training on its use. The manufacturer's operating guidelines should always be followed.

Blade Inspection and Maintenance

Regardless of the type of blade being used on a rotary cut-off saw, there are some basic inspection and use guidelines that should always be followed:

- Check for any damage to the blade (chips, cracks, broken teeth, etc.) and remove from service if necessary.
- Ensure that the blade is securely fastened to the saw and does not vibrate or wobble when used.
- Store saw blades in a clean, dry environment, away from corrosive fluids and fuels.

Rotary Saw Maintenance

Rotary cut-off saws are belt driven. The drive belt tension should be periodically checked and adjusted if needed. Each saw manufacturer will specify the exact procedure for adjusting belt tension and provide guidelines for belt replacement.



Other maintenance procedures include general cleaning, checking that the starter cord properly recoils and ensuring that the saw is full of fuel with the fuel cap secured. More detailed maintenance and use guidelines will be covered in the manufacturer's user manual.

Chain Saws

There are a variety of chain saws used in the fire service. Some are similar to those used by the average homeowner while others are more robust, like those used by farm and tree work professionals. There are also fire/rescue specific chainsaws used for ventilation on a fire ground. While different saws have unique features for given applications, many of them share common components. Some of those components are shown below:



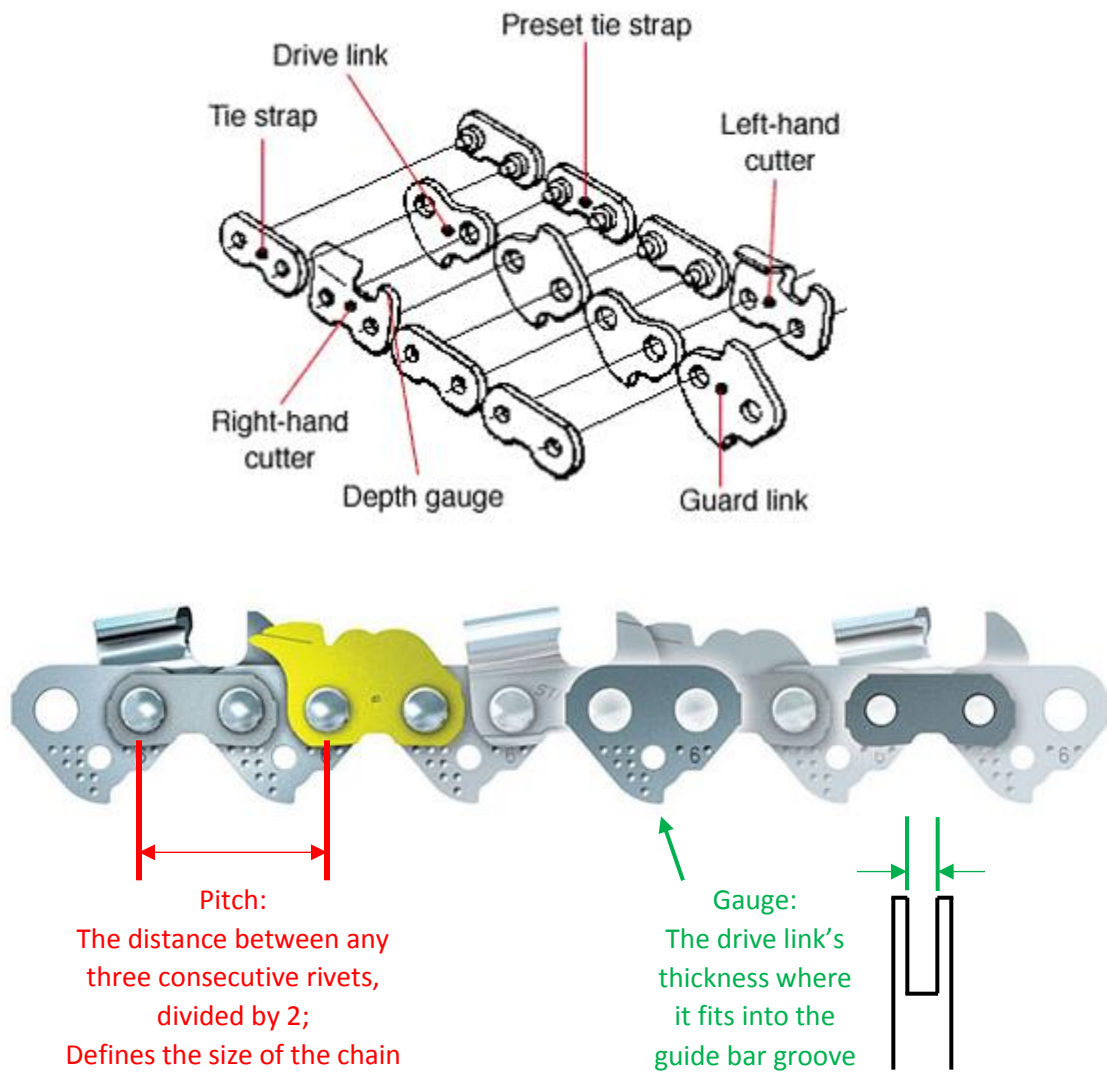
Bars and Chains

Chainsaw bars come in a variety of lengths. Some can be as short as 10 inches while others used for severe duty felling operations can exceed 40 inches in length. Most manufacturers recommend a range of bar lengths based on the intended use.



There is also a wide variety of options for chainsaw chain. Manufacturers design chains for specific cutting applications. A chain used by a professional logging company will be different than one used by the average homeowner. Likewise, there are several varieties of chains designed specifically for the fire service.

To help differentiate between different types of chains, it is beneficial to know some of the basic components and terminology:

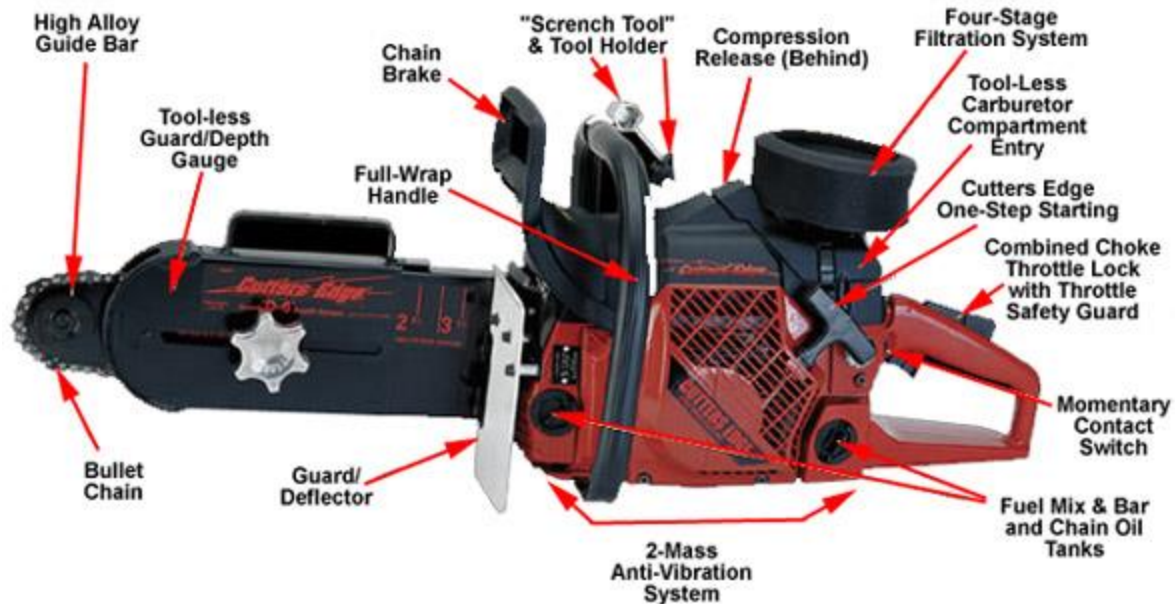


The length of the chain is determined by counting the number of drive links. The drive link count, pitch, and gauge must all be matched with the specific guide bar on the chainsaw.

Fire/Rescue Chainsaws



One popular manufacturer of chainsaws designed specifically for the fire service is [Cutters Edge®](#). The Oregon-based company manufactures several different saw products and accessories. The Multi-Cut® Fire Rescue Saw is designed for fire department ventilation operations and is carried on nearly all truck companies and rescue squads in the Department.



In addition to some of the unique saw features, the chain itself was designed by Cutters Edge® with the fire service in mind. The Cutters Edge Bullet® Chain is a carbide-tipped chainsaw chain designed specifically for the variety of materials that firefighters may encounter during fire/rescue operations. These include common building materials such as roofing nails, joist hangers, nailing plates, flashing, light gauge sheet metal and even some lightweight concrete. The Bullet® Chain is also capable of cutting automotive sheet metal and glass, hurricane glass, bulletproof glass, plastics, fiberglass, and other composite materials.



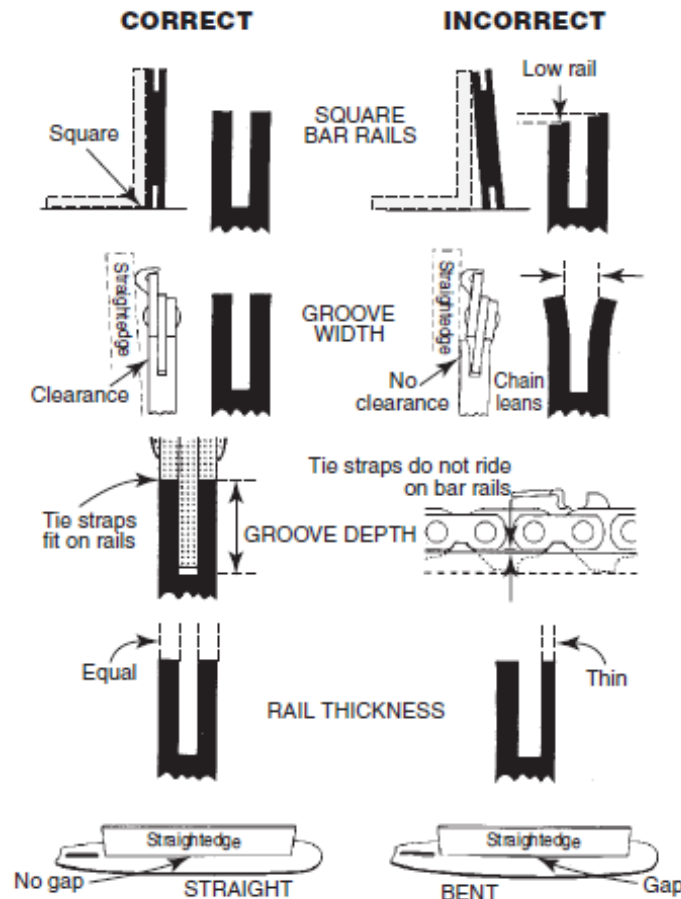
Cutter:
Solid piece cutter without bends or ground-out areas with a sintered carbide insert that creates a larger cutting surface, designed specifically for fire department use

Bullet® Depth Gauge:
Shaped like the nose of a bullet and designed to protect the carbide insert from impact during cutting

Chain and Bar Maintenance and Inspection

Proper chain maintenance is critical for efficient and safe cutting operations. There are several areas that should be the focus of daily inspections:

- **Guide Bar Condition:** The guide bar should be checked for damage, uneven or abnormal wear to the rails, and should not be bent



- **Chain Tension:** Improper chain tension can damage both the bar and the chain. Tension should be checked on a cool bar and chain. Heat from saw use causes the chain to expand. If the chain tension is set while the chain is still hot, the chain will be too tight when it cools. Prior to checking chain tension, ensure the saw is OFF and wear protective gloves. Pull the chain along the top of the bar several times from engine to tip. The chain should feel snug, but still move freely. If the chain catches or requires excessive force to move, it is too tight.



At proper tension, the chain should be in full contact with the bottom of the bar.



When pulling down on the chain at the midpoint along the bottom rails, the drive links on the chain should just clear the rails and snap back into place when the chain is released.



If the chain needs to be tensioned, the procedure outlined in the chainsaw's operating manual should be followed. Different chainsaws may have different designs so the tensioning procedure can differ from one manufacturer to another.

- **Chain Sharpness:** If the cutting tips on the chain are not sharp, the saw will not cut well, causing fatigue to the operator and increased wear and tear on the chain and bar. Chains can be sharpened, although this is typically not done at the station level and should only be performed by a trained professional. The cutting performance of a saw during use is one of the best indicators of chain sharpness. If the saw does not appear to be cutting well, it could be a result of a dull chain.
 - **Cutter's Edge Bullet® Chain:** This chain is designed to allow chips of carbide to break away during normal use. If six or more cutters have 50% or more of the carbide missing, the chain should be repaired and sharpened. Also, if 3 or more cutters in a row or 6 or more total on the entire chain are broken or seriously damaged, the chain should be repaired.

- **Proper Lubrication:** Chainsaws have a chain oiler to minimize wear and tear on the bar and the chain. Ensure that the chain oil reservoir is properly filled with the manufacturer-recommended bar oil. During operation, the chain should always throw off a small amount of oil.



- **General Cleaning:** Buildup of sawdust and debris can inhibit saw performance and increase wear and tear. The saw should be wiped down and cleaned as needed. It may be necessary to remove the clutch cover and clean sawdust and oil buildup found behind it. Ensure that the port for the bar oil feed is free of debris. Consult the chainsaw owner's manual for disassembly and reassembly instructions.



Torches

Torches offer an alternative to saws for metal cutting operations. While their setup and use may not be as quick and easy as a saw, there are certain applications where they may be the best or only option. Similar to welding, torch work is an art that requires proper training and a lot of practice. The amount of time spent training with torches will directly impact performance on an actual incident.



While there are many different types of cutting torches used in both industrial and rescue settings, this module will discuss two types that are carried on rescue squads in Montgomery County.

Oxy/Fuel Torches

Oxygen/fuel (oxy/fuel) torches cut ferrous metals through the process of heating the metal with an oxy/fuel flame and then melting it away with a powerful jet of oxygen. The oxygen/fuel gas flame preheats steel to its ignition temperature. Once this temperature is reached, a stream of high-pressure oxygen is directed onto the steel. The oxygen reacts with iron in the steel to form iron oxide. This oxidation reaction is exothermic, which produces additional heat to help melt any remaining steel. Molten iron oxide, known as slag, is blown out of the cut with the high flow of oxygen.

A variety of fuels can be used with oxy/fuel torches. Each has different chemical (and therefore different cutting) properties with unique advantages and disadvantages. Some common fuel gases are:

- Acetylene: Produces the highest flame temperature of all common fuel gases, making it one of the most popular fuels
 - LEL: 2.5%
 - UEL: 100%
- Propane: Lower flame temperature than acetylene, but has a greater total heat of combustion
 - LEL: 2.1%
 - UEL: 9.5%
- Methyl acetylene-propadiene (MAPP): Lower flame temperature than acetylene, but is less combustible and can be used at higher pressures
 - LEL: 3.4%
 - UEL: 10.8%

In addition to the above gases, another fuel source used with some cutting torches is gasoline:

- Gasoline: Class IB flammable liquid
 - Flash Point: -45°F

- LEL: 1.4%
- UEL: 7.6%

****Chemical properties obtained from NIOSH Pocket Guide to Chemical Hazards**

As indicated previously, acetylene is one of the most popular and widely-used fuel gases for cutting torches. It has the distinct advantage of being able to both weld and cut. The major disadvantage to oxy/acetylene torches is the acetylene gas itself.

Acetylene presents the following disadvantages:

- It has a tremendously flammable range (2.5% - 81%)
- It is extremely hazardous at pressures exceeding 15 psi
- Acetylene molecules (C_2H_2) are held together with a triple carbon bond. While this bond is useful in that it stores a significant amount of energy that can be released during combustion, it is also highly unstable. This makes acetylene gas sensitive to conditions of excess pressure and temperature, static electricity, or mechanical shock.
- Due to its unstable nature, acetylene must be stored under special conditions. The acetylene gas is dissolved in liquid acetone and stored in cylinders containing a porous filler material. The acetylene cylinders must be stored in an upright configuration at all times to prevent loss of the acetone and an increase in the instability of the acetylene.

****Information from U.S. Dept. of Labor Mine Safety and Health Administration (MSHA)**

The unstable properties of acetylene make it a less than desirable fuel of choice for fire/rescue applications where torches are stored and transported on apparatus, not in relatively stable industrial shops.

Petrogen Torch

The Petrogen torch is an oxygen/gasoline torch manufactured by [Petrogen, Inc.](#), based out of Colorado Springs, CO. The Petrogen torch has some of the following advantages over acetylene for rescue work:

- Gasoline is much more stable than acetylene (flammable range is only 1.4% to 7.6%)
- The gasoline remains in its liquid form until it reaches the torch tip
- Gasoline is readily available (carried on all truck companies and rescue squads) and does not need special cylinders for storage



Unlike oxy/acetylene torches that can be used for welding and cutting, the Petrogen torch is only used to cut. However, it performs this task very well.

This unit comes with a small fuel can and a small oxygen cylinder, a backpack style carrier and a 20" torch wand with dual 20' hoses. This system is designed for mild cutting limited to 15 to 20 minutes. If the product that you are cutting is thicker than 1" than this cutting system will only last 5 min. With the Fire and Rescue resources' are so abundant an M bottle would be the preferred oxygen supply for this cutting system. The following is a step by step process for using the Petrogen torch, however personnel must practice with this equipment to be proficient.

To Light & Adjust
1. Select tip and set oxygen tank pressure according to the Cutting Tip & Pressure Chart. (Chart also found on the PETROGEN tank.)
2. Pump gasoline tank pressure to 20 psi.
3. Open gasoline tank valve slowly at first so that the fast-flow check valve does not seat. Then open fully.
4. Purge oxygen hose for at least 5 seconds by depressing the cutting lever.
5. Open torch oxygen valve about 1/2 turn.
6. Open torch gasoline valve until fine mist appears. No drops.
7. Purge oxygen line again.
8. Strike a spark close to the tip slightly to one side.
9. Press tip to steel for about 4 seconds to warm it.
10. Adjust the flame by opening and closing gasoline valve until steel reacts with the brightest orange and red color

To Shut Down
1. Shut torch gasoline valve first.
2. Then close torch oxygen valve.
3. Check to make sure tank filler cap and tank shut-off valves are closed.

There are many tips for the torch wand that offer different cutting capacities. The chart below identifies the tip sizes available in the tool kit with the unit and corresponding cutting capabilities.

CUTTING TIP SELECTION CHART

Tip No.	Thickness of Steel
0	< 1/4"
81	1/4" to 1"
83	2" to 4"

Other tip sizes are commercially available to cut steel materials up to 14" thick.

Safety

During cutting operations, monitor the gasoline tank pressure and ensure it remains above 10 psi. When the gasoline tank pressure reaches 10 psi, re-pressurize the tank to 20 psi. The fast-flow check valve needs 10 psi to operate properly. When operating, keep the gasoline valve fully open to ensure proper operation of the fast-flow check

valve. The oxy-gasoline torch can reach temperatures of 5,200°F, therefore precautions must be taken against burns to personnel as well as ignition of nearby combustibles.

Plasma Arc Torch

The cutting action of a plasma arc torch is the powerful constricted electric arc in combination with a high velocity gas. The electric arc actually blasts the metal into fine particles. Cutmaster 82 from Thermal Dynamics is the plasma cutter carried by MCFRS Rescue Squads.



The Cutmaster 82 requires 220V AC current to operate and an air supply of approximately 100 psi at the unit. These units are portable, however usually limited to the reach of the apparatus electric cord reel supplying the power. The compressed air may be obtained from the apparatus mounted reel or an SCBA cylinder with a regulator.

Safety

The plasma arc process uses and produces high voltage electrical energy. This electric energy can cause severe or fatal shock to the operator or others in the workplace.

In addition to high voltage electricity, the plasma arc process produces very bright ultra violet and infra red light. These arc rays will damage your eyes and burn your skin if you are not properly protected.

- To protect your eyes, always wear a welding helmet or shield. Use the shade of lens as suggested in the following per ANSI/ASC Z49.1:

Arc Current	Minimum Protective Shade No.	Suggested Shade No.
<300	8	9
300-400	9	12
400-800	10	14

- In addition to the helmet or shield, always wear safety glasses with side shields, goggles or other protective eye wear.
- Wear welding gloves and suitable clothing to protect your skin from the arc rays and sparks.
- Keep helmet and safety glasses in good condition. Replace lenses when cracked, chipped or dirty.
- Protect others in the work area from the arc rays. Use screens or shields.

Portable Fans

Portable fans provide the fire service a vehicle for achieving one of several critical elements of any firefighting effort: timely and effective ventilation of an affected structure. Whether carried out as part of a well-coordinated fire attack, or during overhaul operations, the ability to rapidly remove smoke and heat from an structure is paramount to any successful firefighting operation. Observable reductions in property damage, more tenable firefighting conditions, and overall improvements in firefighter health and safety are tangible benefits which occur with the use of portable ventilation fans.

Various manufacturers produce fire department ventilation fans. As such, several varieties of fan models and styles exist. Fan sizes may range from small (often electric or water-powered) to larger gasoline-powered blowers. In some instances, personnel may have the availability of much larger, trailer-mounted exhaust fans, similar to those in use by airboats. Regardless, each fan has specific applications and limitations. As such, the Rescue Squad driver/operator must be knowledgeable of the various types and specific operating characteristics of all fans carried on his/her unit.

Power Source(s)

The type of fan employed on the fireground is largely driven by the nature and availability of specific power sources. Until the early 1990's, the fire service utilized electric "smoke ejectors" for all ventilation applications. This resulted from the fact gasoline-powered fans had yet to be introduced to the fire service.



The introduction of gasoline-powered portable fans drastically altered the "standard" of fireground ventilation. These fans consist of a small, frame-mounted, 4-cycle motor which is connected to a multiple-prop blade. Gasoline-powered fans offer the versatility of compactness and mobility, while simultaneously producing enormous volumes of air.

One of the major drawbacks of the gasoline powered portable fans is the large amount of carbon monoxide produced by the motor that is then drawn into the fan and forced into the building or area being ventilated.

Size/Capabilities

The specifics of fire service ventilation fans vary greatly from manufacturer to manufacturer. Detailed information regarding a fan's specifications can be found within the manufacturer's instruction manual or on a data plate on the fan.

Maintenance

Fans require considerable maintenance and cleaning in order to maintain operational readiness. Important factors to consider include:

- ◆ Electric motors must be kept clean to allow for proper ventilation of internal components and related circuitry.
- ◆ Shrouds must be securely fastened to prevent vibration and the introduction of particles into the airstream.
- ◆ Foot mounts or skids must be in place to ensure the fan operates without unnecessary vibration.
- ◆ Fuel tanks must be kept full to ensure uninterrupted operations during incidents.
- ◆ Oil levels must be maintained within an acceptable range in order to limit wear and tear on engine components. Many modern motors will shut down or not start if there is not sufficient oil in the motor.
- ◆ Fan blades/propellers must be free of dents, nicks, cracks, or other defects.
Warning: Damaged blades could fail during operation and lead to serious firefighter injuries or death!
- ◆ The fan blade/propeller must be installed with the pitch in the correct direction.
The blade/propeller should have an arrow or indicator to identify which side should face forward.